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(11) **EP 1 243 341 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
25.09.2002 Bulletin 2002/39

(51) Int Cl.7: **B05B 7/06, B05B 12/08**

(21) Application number: **01830715.7**

(22) Date of filing: **19.11.2001**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE TR**  
Designated Extension States:  
**AL LT LV MK RO SI**

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(30) Priority: **23.03.2001 IT TO010278**

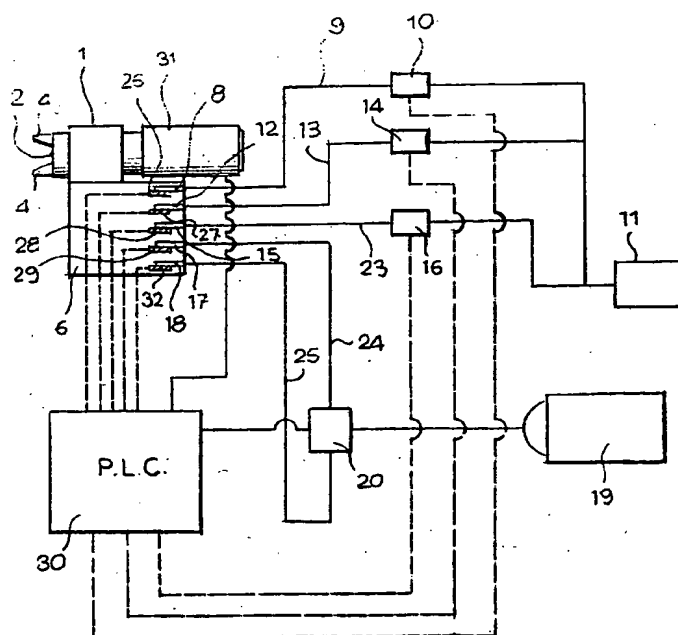
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(54) **Automatic spray gun**

(57) Automatic spraying gun, comprising a body (1), with a spraying nozzle (2) and passages (8, 12, 15, 17) for connecting to tubes (9, 13, 23, 24) supplying compressed air and a pressurised substance to be sprayed. Electronic pressure transducers (26, 27, 28, 29) are op-

eratively associated to said passages (8, 12, 15, 17) and connected to an electronic control unit (30) arranged to automatically adjust the pressure of the air and/or the pressure of the substance to be sprayed according to the transfer efficiency optimisation parameters.

*Fig. 2*



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## Description

**[0001]** This invention relates to guns for the application of covering substances, such paint, chemical substances, powder and similar by spraying.

**[0002]** More specifically, this invention related to an automatic spray gun of the type comprising a spray nozzle and passages for connecting to compressed air pipes and a pressurised substance to be sprayed by means of a fitting and supporting base.

**[0003]** Guns of this type are widely used, for example, in the automotive industry for painting the chassis of motor vehicles. In such applications, a plurality of such automatic guns are fitted, for example, on a robot device which can move with relation to the chassis. These devices are equipped with controller units fitted with pressure gauges indicating the pressure of the compressed air supplied to the various guns in an analogue fashion. The compressed air pressure can be adjusted manually by means of specific valves according to the operative parameters, such as type of paint, required thickness of the coating, relative movement speed between chassis and guns, the reciprocal distance, etc.

**[0004]** Also the pressure of the substance to be sprayed, in this case paint, is adjusted manually, by means of specific turning knobs, directly applied each to the respective gun.

**[0005]** Similar arrangements are employed for different applications, such as, for example, spraying chemical substances for tanning leather, powders in food industries, etc.

**[0006]** The manual adjustments described above obviously depend on the skill and experience of the person, without offering particular guarantees in terms of repeatability. This is not only a problem in relation to the uniformity of quality standards of the painting process, but also effects what is known as the transfer efficiency. This term is used to indicate the ratio between the mass of the substance effectively applied and the mass of the substance sprayed from the spray nozzle of the gun, expressed as a percentage. This is crucial measurement for the cost-effectiveness of the spraying system and also in relation to the environmental impact deriving from the volatility of the sprayed substance, which is sometimes toxic and in any case not environment-friendly. At the traditionally rather high spraying pressures (5-6 bars), the automatic spraying guns present a low transfer efficiency, typically in the order of 30-40%. This entails a large waste of material and, consequently, high emissions, specifically harmful in the case of paints diluted with solvents. Recent standards in this matter set forth lower spraying pressures, for example, not exceeding 1-2 bars, to lower the level of harmful emissions. The automatic spraying guns operating at these low pressures, called "HVLP" (High Volume Low Pressure) guns are able to ensure a transfer efficiency at least equal to 65%, naturally providing the respective settings are correctly made. With manual adjustment

methods, this may not always be ensured, also when the structural and functional conformation of the gun are suitable to obtain such transfer efficiency values.

**[0007]** From US-A-5645884 and US-A-4593360 computerized control systems for automatic spraying guns corresponding to the preamble of claim 1 are known, which however are not inherently suitable to provide the required transfer efficiency values.

**[0008]** The object Purpose of this invention is to solve the aforesaid problems, and more specifically to provide an automatic spraying gun of the type described above whose functionality is not only not dependent on the adjustment skill and capacity of the operator, but even such as to ensure a transfer efficiency degree appreciably higher also with respect to the already known computer controlled spraying guns.

**[0009]** According to this invention, these purposes are obtained thanks to the features set forth in the characterising part of Claim 1.

**[0010]** As mentioned above, the optimisation parameters of the transfer efficiency are directly related to the type of substance to be sprayed, to the thickness of the coating which is to be obtained, to the position of the gun with respect to the surface to be coated and to the relative movement speed, etc. These parameters are easily classified and catalogued and are suitable to be entered, by means of simple algorithms, in specific computer programs by means of which the electronic control unit will operate. In this way, in addition to ensuring constant maintenance of quality standards at the maximum transfer efficiency levels, the adaptation of the gun for different applications can be obtained immediately and safely, because it will not depend on the skill of the operator.

**[0011]** The automatic spraying gun normally comprises an axially mobile pin for adjusting the gap through said spraying nozzle: in this case, the invention provides that said pin is operatively associated to a driven actuator connected to said electronic control unit. In this way, all the possible settings of the automatic spraying gun according to this invention are automated.

**[0012]** This invention will be better explained by the following detailed descriptions with reference to the accompanying figure as non-limiting example, whereas:

- figure 1 is a prospective schematic view of an automatic spraying gun according to this invention and
- figure 2 is a diagrammatic view showing the adjustment system of the gun according to this invention.

**[0013]** With initial reference to figure 1, an automatic spraying gun according to this invention essentially comprises a body 1 with a spraying nozzle 2 to which an axially mobile pin is associated, which free extremity is indicated with numeral 3, for adjusting the gap through the nozzle 2. Numeral 4 indicates two elements projecting axially from diametrically opposite parts of the spraying nozzle 2 and in turn equipped with flow holes 5.

[0014] The spraying nozzle 2 and the flow holes 5 communicate in a way which is known, with the corresponding fluid passages in a fitting and supporting base 6 to which the body 1 is fastened. The base 6 is arranged for fitting, normally in an adjustable fashion, onto a support 7 consisting of, for example, the arm of a painting robot.

[0015] Said fluid passages are schematically illustrated in figure 2 (without the connection to the body 1, which is however conventional). The passages comprise a first passage 8 connected to a tube for supplying compressed air 9 from a compressed air source 11 via a first solenoid valve 10; a second passage 12 connected to a second tube for supplying compressed air 13 also connected to the source 11 via a solenoid valve 14; a third passage for supplying compressed air 15 also connected to the source 11 via a third pipe 23 and a solenoid valve 16; a passage 17 and a passage 18 (optional) respectively for input and recirculation of a pressurised substance to be sprayed, for example a mixture of paint and solvent. The passage 17 is connected to a supply source 19 of the substance to be sprayed by means of a hydraulic pump 20, more specifically a geared pump, and a tube 24. The passage 18 recirculates the sprayed substance in excess to the pump 20 via a tube 25.

[0016] The first supply passage of air 8 and the input passage 17 of the substance to the sprayed are connected to the spraying nozzle 2. The second supply passage 12 is connected to flow holes 5 for sending a peripheral fan of pressurised air around the spraying nozzle 2. The third supply passage 15 is, on the other hand, connected to a control system, also known and not illustrated in drawing for the sake of simplicity, by means of which the flow of air and of the substance to be sprayed via the gun is respectively enabled or disabled.

[0017] The input passage 17 is also connected to the spraying nozzle 2, while the passage (optional) 18 is used for recirculating the substance which is not sprayed to the pump 20.

[0018] According to this invention, an electronic pressure transducer, respectively 26, 27, 28, 29 (and 32, where relevant), in each of the passages 8, 12, 15, 17 (and 18, where relevant) inside the base 16. The electronic pressure transducers 26-29 are miniaturised, for example, of the ceramic capacitance type made and marketed by ENTEC GmbH. These transducers output digital signals indicating the pressure inside the respective passages 8, 12, 15, 17 (and 18, where relevant), which are sent to an electronic processing and controlling unit 30, which is operatively connected to the controlling stages of the solenoid valves 10, 14 and 16 as well as the pump 20.

[0019] The solenoid valves 10 and 14 are normally of the proportional type, while the solenoid valve 16 can be simply an on/off valve.

[0020] The electronic control unit 30 is programmable by means of specific algorithms so to automatically ad-

just, during operation, the pressure of the air sent to the spraying nozzle 2 and the flow holes 5 via solenoid valve 10 and solenoid valve 4, respectively, as well as the pressure of the substance to be sprayed sent to the spraying nozzle 2, via the pump 20, according to the transfer efficiency optimisation parameters. The electronic control unit 30 also activates and deactivates the gun by means of the control solenoid valve 16.

[0021] According to an additional aspect of this invention, the control unit 30 is also able to automatically control the axial adjustment of the mobile pin 3 for changing the gap of the substance to be sprayed via the nozzle 2. To this effect, the pin 3 is operatively associated to a driven actuator, typically an electrical motor 31, also connected to the electronic control unit 30.

[0022] The use of the automatic spraying gun according to this invention is particularly advantageous in combination with identical automatic guns for making also complex spraying systems: in this case, the various guns and the respective electronic pressure transducers and the respective electrical actuators can be jointly or independently controlled, one with respect to the other, by the same electronic control unit 30.

[0023] Naturally, numerous changes can be implemented to the construction and forms of embodiment of the invention herein envisaged, all comprised within the context of the concept characterising this invention, as defined by the following claims. For example, the pressure transducers can be housed totally or in part directly inside the body 1 of the gun instead of in the base 6.

[0024] Furthermore, the electronic control unit 30 can be operatively connected to additionally electronic delivery or volume transducers of the air and/or of the substance to be sprayed fed to the gun, as well as additional electronic transducers for measuring the temperature of the air and/or of the substance to be sprayed. The signals from these transducers, not illustrated herein being within the scope of knowledge of sector engineers, will be concatenated with those described above and processed with the electronic control unit 30 for additionally optimising the transfer efficiency during gun operation.

## Claims

1. Automatic spraying gun, comprising a body (1), with a spraying nozzle (2) and passages (8, 12, 15, 17) for connecting, via a fitting and supporting base (6), to supply tubes (9, 13, 23, 24) supplying compressed air and a pressurised substance to be sprayed, wherein electronic pressure transducers (26, 27, 28, 29) are operatively associated to said passages (8, 12, 15, 17), said electronic pressure transducers (26, 27, 28, 29) being connected to an electronic control unit (30), **characterised in that** said pressure transducers (26, 27, 28, 29) comprise a first transducer (26) associated to a first passage (8) connected to a tube (9) supplying compressed

air to said spraying nozzle (2) via a first solenoid valve (10), a second transducer (27) associated to a second passage (12) connected to a tube (13) supplying compressed air peripherally to said spraying nozzle (2) via a second solenoid valve (14), a third pressure transducer (29) associated to an input passage (24) of the substance to be sprayed via a pump (20), a fourth passage (28) connected to a tube (23) of compressed air which controls the gun via a third solenoid valve (16), said first, second and third solenoid valves (10, 14, 16) and said pump (20) being controlled by said electronic control unit (30), and said electronic unit being arranged to automatically adjust, in a programmable fashion, the pressure of the air and/or the pressure of the substance to be sprayed according to the transfer efficiency optimisation parameters.

2. Automatic spraying gun according to claim 1 **characterised in that** said pressure transducers (26, 27, 28, 29) are housed at least in part within said fitting and supporting base (6).
3. Automatic spraying gun according to claims 1 or 2, **characterised in that** it also comprises a fifth pressure transducer (32) associated with a recirculation passage (25) of the substance to be sprayed to said pump (30).
4. Automatic spraying gun according to any of the claims above, comprising an axially mobile pin (3) for adjusting the gap through said spraying nozzle (2) **characterised in that** a driven actuator (31) controlled by said electronic control unit (30) is operatively associated to said pin (3).
5. Spraying system, particularly paint spraying system, **characterised in that** it comprises one or more automatic spraying guns according to one or more of the claims above, controlled either jointly or independently by said electronic control unit (30).
6. Spraying system according to claim 5 **characterised in that** it also comprises electronic delivery or volume transducers of the compressed air and/or of the substance to be sprayed, as well as electronic transducers for measuring the temperature of the compressed air and/or of the substance to be sprayed operatively connected to said electronic control unit (30).

Fig. 1

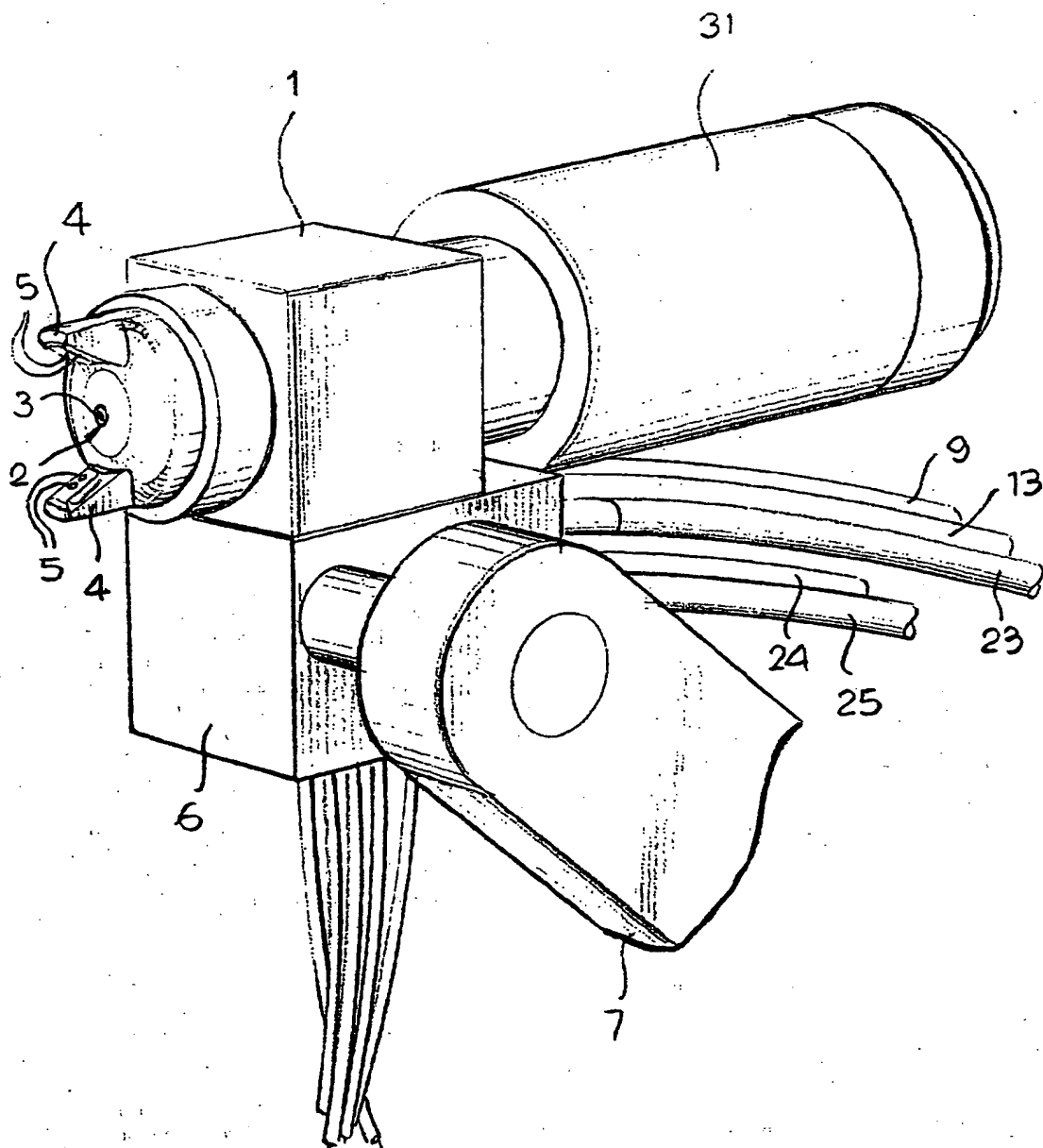
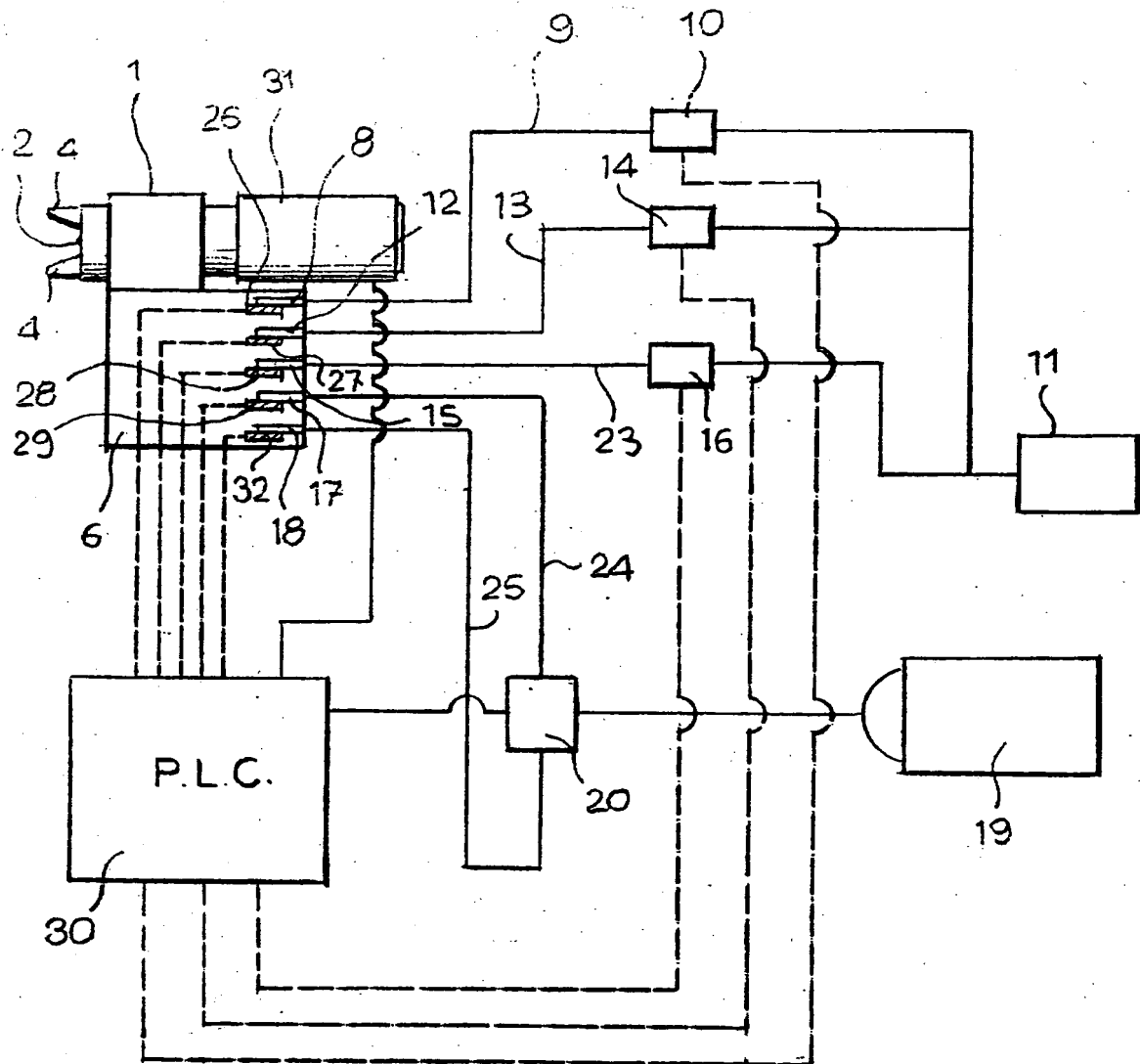


Fig. 2





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Application Number  
EP 01 83 0715

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